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Sustainable Agriculture Sector

Sub-program 4.1 - Adaptation through Informed Decision Making

Final Report on Pilot #3
Improving Resource Management
through
Local Data Analysis and GIS Technology

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A. Project Background, Objectives, and Workplan

Under the Green Plan program in the mid to late 1990's, the District 15 Agricultural Development and Diversification (ADD) Board began assembling land and water resource information in a GIS format. District 15, located in central Saskatchewan, was the first local producer group in the province that intended to utilize GIS information to address sustainable agriculture issues, and to assess various options for improved land management.

Under this AFIF project specific objectives were developed to build upon this initiative.

1. To develop improved resource information to assess land and water issues and promote sustainable cropping, livestock, and land use options within District 15, using local data analysis and GIS technology.

2. To encourage the adoption of sustainable land use practices on the most appropriate areas within District 15 through an effective extension program.

3. To assist local organizations in adopting GIS technology as an effective tool for agricultural land resource management.

Key areas of activity were identified in a project workplan. These included:

1. Development of Resource Information
   a) Analysis of soils and landscapes for various crop types and land uses
   b) Analysis of soils and landscapes for precision farming applications
   c) Identification of water resource potential/limitations
   d) Mapping of noxious weed areas
   e) Identifying areas suitable for intensive livestock production

2. Evaluating the Social/Economic Issues affecting Sustainable Agriculture Practices
3. Development of Targeted Information Packages
4. Implementation of an Extension Program

B. Final Year Project Activities (2001/02)

Three major activities were completed in the final year: development of an Internet Map Service, development of a GIS application for municipal assessment data, and ongoing ADD Board GIS services to local groups and individuals.

1. Internet Map Service

This activity built upon the previously developed District #15 GIS website, by providing a more interactive and powerful map information tool for the public. Development of this service was implemented by PFRA's GIS Unit in Regina (ie. Troy Riche, Peter Murphy, Allison Nell, and Karla Magnusson) using the ArcIMS software.

Through several meetings, considerable input and feedback was provided by PFRA Rosetown staff (ie. Scott McNally and Dennis Haak) as well as the District #15 ADD Board (ie. Tim Fox and Dave Ehman). This website also provides a more comprehensive use of the Saskatchewan Soil Survey 1:100,000 database. The new website is a pilot under PFRA's National Land and Water Information Service, and can be accessed at: http://192.197.71.108/ims/addboard15/maps.html.

2. GIS application for Municipal Assessment Data

This activity was coordinated and implemented by Dennis Haak, PFRA, Rosetown, and involved the following steps:

- accessing digital municipal assessment data from the Saskatchewan Assessment Managment Agency (SAMA) for the RM's of 190 and 222.
- understanding file structure and information of existing database.
- development of a new database file structure suitable for GIS application.
- development of a polygon based landowner parcel file and linking municipal assessment data to this parcel file.
- development of some simple quarter section based analyses such as average final ratings, land use, and areas of marginal annual cropland targeted for conversion to perennial forage.

The last two steps were only completed for the Rural Municipality (RM) of Craik. This GIS application was demonstrated at a meeting of District #15 ADD Board and PFRA's GIS Unit. Several attempts were made to demonstrate the application for SAMA, but so far this hasn't been done.

3. Ongoing District #15 GIS Support

Tim Fox has continued to provide GIS services to local groups and individuals through the RM of Craik office. This service includes providing maps and aerial photos to clients, and maintaining an up to date landowner file. Linda MacMillan has continued to provide administrative support and maintenance services for District #15's website: http://www.addboard15.sk.ca/.

D. Communication Events

1. ADD Board newsletter distributed to all farmers (about 1500) in District 15; contained 3 articles on the beginnings of this project written by ADD Board representatives (summer 1998)
2. ArcExplorer GIS viewer and a digital copy of black and white aerial photography installed on RM office computers within District. (Tim Fox, winter 1999)
3. Project update to 150 people at RM of Craik's ratepayer meeting (Dennis Haak, Troy Riche, spring, 1998)
4. Display poster on GIS based information in District 15 for GIS Workshop in Saskatoon attended by 150 people (Scott McNally, April, 1999)
5. Paper on integrating land cover and soils data to identify areas suitable for various land uses, such as conversion of marginal annual cropland to perennial forage. This paper was presented to the PFRA Today Symposium attended by 100 people in Regina and the Soils and Crops Workshop attended by 50 people in Saskatoon (Dennis Haak, February, 2000)
6. Presentation on GIS Applications for RM's and upcoming District 15 website development to 300 people at NSWCP GIS conference in Edmonton (Tim Fox, March, 2000)
7. A website was developed and launched to allow free public access to over 200 map images and aerial photographs from District 15 (Summer, 2000)
8. ADD Board newletter distributed to all residents (about 2400) in District 15; two full colour pages were devoted to promoting the new website (Fall, 2000)
9. Overview and interim evaluation of the project presented to a group of 50 people at an AFIF Conference in Regina (Dennis Haak, November, 2000)
10. Overview of GIS applications and District 15 website to 45 people at Rural Municipal Administrators Association District 2 meeting (Tim Fox, Nov. 2000)
11. Workshop for 8 producers at Kenaston, on using a free computer software program to calculate areas and lengths on aerial photographs (Dennis Haak, December, 2000)

12. Presentation on RM GIS Applications and District 15 Website to 550 people at Agriculture Services Board of Alberta meeting at Edmonton (Tim Fox, Jan, 2001)
13. Presentation on GIS capability to 150 people at RM of Craik's ratepayer meeting (Troy Riche, March 2001)
14. New ArcIMS website launched to provide more powerful and interactive GIS mapping capability. (Fall, 2002)
15. Presentation on Internet Mapping Service pilot to 150 people at RM of Craik's ratepayer meeting (Troy Riche, March 2002)
16. Demonstration of District 15 ArcIMS pilot website to 50 people at PFRA's Land Management Service Annual Meeting (Troy Riche, March 2002)
17. Demonstration of District 15 ArcIMS pilot website to 70 people at the National Land and Water Information Service (NLWIS) workshop in Ottawa (PFRA GIS Unit, March, 2002)
18. Presentation on RM GIS Applications and District 15 GIS website to 350 people at RM Administrators Convention in Saskatoon (Tim Fox, May, 2002)

E. Project Achievements

1. Development of Resource Information

a) Soil Survey 1:100,000 Data Development
The initial part of this process was to manipulate existing soils data into 25 variables that were each mapped separately. Secondly, value added information was created to provide recommendations for land use changes. This included the following specific maps:

- Marginal annual cropland suited for conversion to perennial forage *
- Productive forage land suited for more intensive management *
- Areas having slight to moderate soil salinity suited for special management using precision farming techniques
- Areas having moderate slopes and/or variable soil texture that may be suited for variable management using precision farming techniques

These activities, particularly the value added information, fulfilled items 1a and 1b from the workplan, outlined in section A. *Note: PFRA's Land Cover data was integrated with the soils data to create this information.

b) SaskWater's Groundwater Well Database

Development of a quarter section point coverage included # wells, depth of wells, depth to water bearing zone, thickness of water bearing zone, artesian rise, and pumping rate. Unavailability of other surficial and groundwater data in digital form made it impossible to do a comprehensive analysis of water resources potential and limitations within District 15 (workplan item 1c).

c) Census of Agriculture, Statistics Canada, 1986, 1991, 1996

Summarized data by RM was manipulated into 27 variables which were each

mapped separately. Information included farm structure, size, tenure, land use, crop types, livestock types, conservation practices, crop inputs, and farm economics. For each variable a comparison was made between RM's. A report was generated outlining key differences between RM's. This data provides an opportunity to investigate the social and economic issues related to sustainable agriculture (ie. workplan item 2). However, due to confidentiality Statistics Canada does not provide information on individual farms or groups of farms within an RM. Therefore, it is difficult to assess any interactions between sustainable agriculture practices and social/economic factors.

d) Leafy Spurge Weed Infestations

Leafy spurge has increasingly become a problem weed on pastures and forage land, not only in District 15 but other parts of the prairies. In 1998, District 15 ADD Board identified 120 quarter sections with probable leafy spurge infestations. In June 1998 these quarter sections were photographed using visible colour film taken from a plane. The images were digitally scanned and crudely geopositioned using georeferenced black and white aerial photography (see item e, below). At the same time about 15 sites were chosen to conduct ground truthing to verify the photo information.

The goal of this work was to map the extent of leafy spurge infestation within each quarter section, and then use this information as a baseline to evaluate the impact of beetle releases as a biological control of the weed. There were approximately 10 beetle release sites included on these photos.

Unfortunately, after several attempts it became clear that it was not feasible to properly classify the photos for leafy spurge infestation. This was due to the high costs associated with obtaining a more accurate georeferenced product and accounting for all colour variations associated with the leafy spurge reflectance. Nevertheless, it was possible to do a rough visual assessment of leafy spurge infestation on each quarter section photo. It was interesting that about one-quarter of the photos, showed no leafy spurge, which was confirmed through a field inspection. In the end only part of the goal associated with workplan item 1d was realized.

e) Black and White Aerial Photography

Black and white aerial photography obtained under the previous Green Plan program, was georeferenced and thereby became integrated with other GIS datasets. While this information has less application for the analysis of issues at the regional level, it serves as useful information for landowners and local groups in making site specific sustainable land management decisions.

f) Municipal Assessment Data

This work has already been described in section B2. The development of this GIS database increases the capability of RM's to utilize and manage their own data in their own day to day activities. The analyses performed on land use and

soil/landscape characteristics, address similar issues that were analyzed using PFRA's land cover and the Saskatchewan Soil Survey database (see section E1a). However, the level of detail with municipal assessment data may be greater.

g) Areas suitable for Intensive Livestock Development

A methodology was developed for identifying areas at the local (ie. RM) level that may be suitable for intensive livestock development. Key factors included acceptable separation distances from human settlement, and highly productive annual cropland for receiving manure applications. For the latter factor key data sources included PFRA's Land Cover and the Saskatchewan 1:100,000 Soil Survey database. This activity addresses workplan item 1e. Training and instructions were provided to the District 15 GIS technician, however, maps were not completed for District 15 due to resource constraints.

h) Other complementary datasets

Other complementary datasets that were developed for District 15 include PFRA's Land Cover, various themes from the National Topographic System base maps (ie. topography contours, hydrography contours, and roads), and land ownership files for the RM's of Craik and Dufferin.

2. Development of Targeted Information Packages

Initially, information packages consisted of maps in the form of hardcopy and computer image files. For example, a series of maps were produced for the RM of Craik and placed in the RM office for public viewing. Information was also presented in several ADD Board newsletters which were distributed to all rural residents within District 15. An ArcView project was developed which provided the framework for a District 15 GIS profile.

It was soon realized that a much more efficient way to provide information to a wide variety of groups and individuals was through the Internet. Therefore, a website was designed to provide map information in a structured format to the general public. The files for this website were served through a community Internet service in Craik, and was launched in the summer of 2000. It can be accessed at http://www.addboard15.sk.ca/.

In the final year of the project considerable work was spent on developing an ArcIMS application for the District 15 data. This type of internet service is much more powerful and interactive than image files placed into HTML pages. This type of application has the following specific advantages over image files:

- turn various themes of information on or off for the same map
- view more than one theme of information at one time
- utilize scale dependancy capability where more detailed information automatically turns on when one zooms into one area
- utilize analytical tools such as selecting features, setting buffered areas around selected features, and measuring distances and areas

The ArcIMS site is located at http://192.197.71.108/ims/addboard15/maps.html.

F. Project Results

Project results and impacts are discussed below in the context of striving to achieve the initial objectives.

Objective 1 To develop improved resource information to assess land and water issues and promote sustainable cropping, livestock, and land use options within District 15, using local data analysis and GIS technology.

Through this project considerable progress was made in developing improved resource information to assess land and water issues. Of particular note, was the ability to utilize soil data together with land cover data, to identify areas for improved land management, such as areas suitable for conversion to perennial forage, more intensive forage management, and intensive livestock development. However, more could have been accomplished, especially with issues relating to water resources.

This project demonstrated that considerable resources in time, money, and expertise are required to develop this type of information. For example, considerable data manipulation is required to map specific variables found in data sets such as the Census of Agriculture and the Saskatchewan 1:100,000 soils database. Even more work is required to integrate data that describes the inherent properties of soil, land and water resources, with data that describes the management of these resources. This integration is crucial to fully understand the impacts of current and changes in management on soil, land, and water resources.

Objective 2 To encourage the adoption of sustainable land use practices on the most appropriate areas within District 15 through an effective extension program.

As already mentioned the extension program consisted of the two websites, the ADD Board newsletter, and presentations at various local, regional, and provincial meetings. Considerable effort was expended at making GIS based information widely accessible, and notifying people of this information.

Much less time was spent in identifying targeted groups of people within District 15, to encourage adoption of specific land use practices. Nevertheless, the ADD Board and various RM's did try to develop some significant agricultural development projects during this time. This included developing a pelleting plant for grain screenings, and harvesting road allowances for silage. Interestingly, the ADD Board and RM's did not use GIS extensively in developing these ideas. In the end both of these ideas did not materialize.

There was little work to evaluate the effectiveness of extension efforts, such as the websites. Nevertheless, the following table provides a listing of the number of visits made to the first District 15 website.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000						68	76	53	65	103	308	381
2001	500	437	363	381	510	506	50	884	953			
2002	1236	1062	946									

Note: Visits refers to the number of requests for information from unique addresses over incremental 30 minute periods. Data is not available from Oct to Dec 2001 due to difficulties with tracking data on the server.

It is interesting that a dramatic increase in visits occurred in the fall of 2000, which coincides with the time that the ADD Board newsletter was distributed to residents within District 15. It also encouraging that the number of visits has generally been increasing with time.

It is difficult to know if these extension efforts made any impact on actual land use changes in the District. It is presumed that while there may have been some positive impact, the amount has probably been fairly low, for the following reasons:

- while most producers found the black and white aerial photos useful, other information was too general to apply at the farm or field level.
- some producers do not use computer technology to help make management decisions, and therefore felt uncomfortable utilizing this information.
- there was some hesitancy or inability for the ADD Boards or RM's to actively promote and implement sustainable and targeted land management programs. Some possible reasons could be:
  - many sustainable practices had already been promoted and implemented under previous programs like Save Our Soils and Green Plan
  - the ADD Board did not have enough core resources to effectively function as a strong organization
  - RM's traditionally have a stronger focus on infrastructure issues such as roads, than sustainable agriculture
  - a number of attempts by the ADD Board and RM's to develop significant agricultural development projects failed due to a number of factors, such as the inability to secure sufficient capital investment.

Objective 3 To assist local organizations in adopting GIS technology as an effective tool for agricultural land resource management.

Considerable effort was expended in assisting RM's in adopting GIS technology. Two out of 7 RM's (Craik and Dufferin) decided to become involved in a GIS system. These two RM's were particularly interested in using GIS to assist in activities directly related to their own operation. This included keeping an up to date inventory of land ownership, road maintenance, and other infrastructure such as signs, culverts, etc. The cost of developing these types of applications were borne

primarily by the RM's themselves, with only a small percentage covered by AFIF project funds. The rationale for this was that these applications were not directly related to sustainable agricultural practices. Due to resource constraints these RM's were able to develop only a few of these applications, such as land ownership.

Some efforts were made to utilize project contribution funds at the local level, for analyzing land management issues. However, this was essentially unsuccessful, due to factors already discussed under Objective 2.

In summary, this project made considerable progress in developing GIS based databases and information packages (ie. websites) to increase accessibility of this information. However, much less progress was made in applying this information to develop programs that result in land use and land management changes.

G. Project Impacts

Over the last decade there has been a growing interest among local organizations and the federal and provincial governments to utilize GIS as a tool to develop information on sustainable agricultural practices. For example, a number of Alberta counties have begun using GIS in their operations. Another example is the National Land and Water Information Service being developed by AAFC.

There are a number of important lessons that can be learned from this project, that can impact expanded initiatives in the future.

1. Developing and utilizing GIS based information requires significant resources. This resources include computer hardware/software, data acquisition, and the utilization of trained GIS and land resource specialists.

2. This project involved a number of organizations including AAFC-PFRA, District 15 ADD Board, and various RM's. All of these organizations have a role to play in this type of work, and all organizations require significant resources to fulfill their roles.

3. While the exact roles of various organizations may be somewhat flexible and overlap, it seems logical that broad scale organizations like PFRA and the Information Services Corporation of Saskatchewan (ISCS) have a role in facilitating GIS capability and developing GIS based data and information, while local organizations must take the lead in applying this information to address local issues.

4. It could be argued that within Saskatchewan, organizations like ADD Boards and RM's may not be the most appropriate local organization to develop GIS based information. Some recent initiatives suggest that organizations like Regional Economic Development Authorities (REDA's) and Community Futures organizations may be preferable. These organizations have considerably more resources, and their planning and development focus can benefit from a GIS information service.

5. At the local level, GIS can be a valuable tool for addressing a broad range of issues and activities, not just sustainable agricultural practises. This includes a variety of economic, environmental, and social activities. It could be argued that due to the high resource requirements for GIS, this activity should be performed by a single broad focused group at the local level, rather than different local groups covering the same geographical area. Such an organization probably does not currently exist in Saskatchewan.